



Photogrammetric Measurement of Cabin Bracket Riggings on the Airbus 350

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The goal of this project was to obtain accurate 3D measurements of the many brackets that support the overhead luggage bins in the new Airbus 350 aircraft. The measured area was more than 21 m in length, and one of the key requirements was to perform the measurement with little or no impact on production. Photogrammetry was an ideal solution in this regard. Its other compelling attributes include no warmup time, a fast rate of measurement, the acquisition of all points in real time, the ability to work on the unstable aircraft flooring, and quick and reliable installation and removal of a tooling target without interfering with production. Many of the tooling targets were specially customized “feature targets” with the ability to measure points of interest

without targeting them directly (which is often impractical or even impossible to do). The 3D measurement in this project was accomplished with a multiple-camera V-STARS system from Geodetic Systems Inc. of Melbourne, Florida, employing four of the company’s highest-accuracy DynaMo D12 cameras. The implementation of the measurement was highly automated and included a customized user interface developed especially for this particular application.

INTRODUCTION

Based on an individual airlines’ purchase configuration, each Airbus 350 must be rigged specifically for that particular

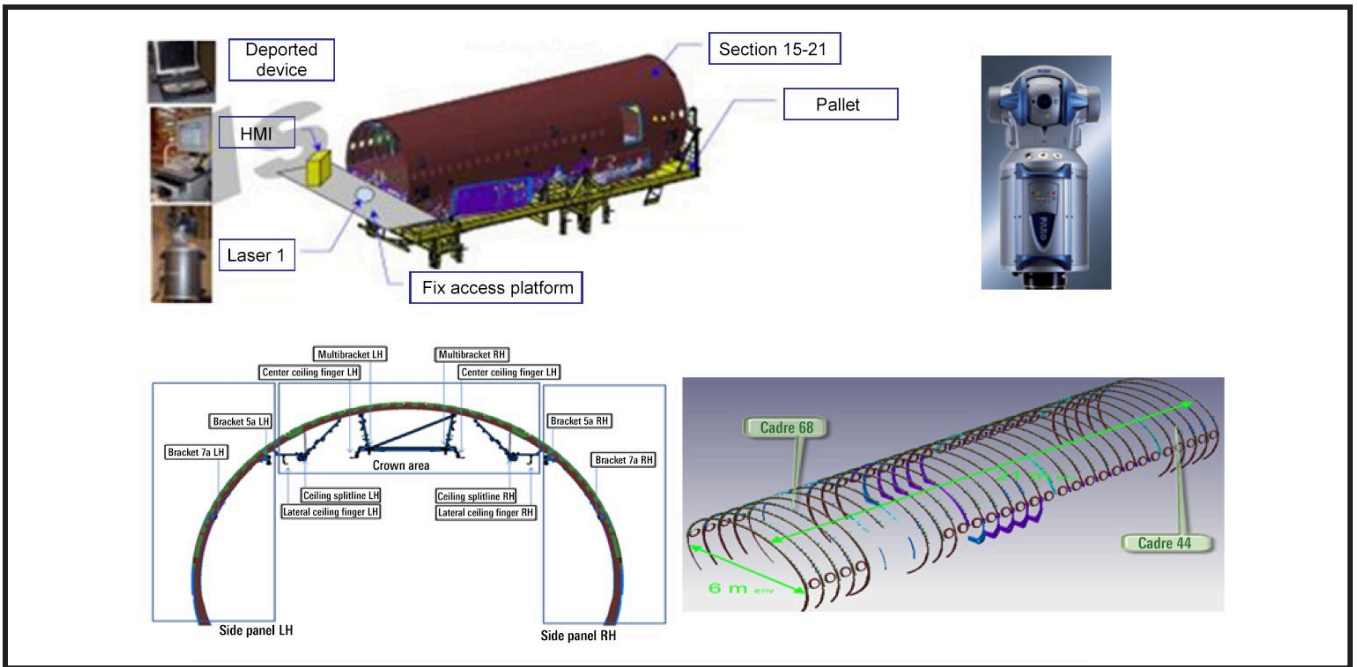


Figure 1. Schematics for cabin bracket installation and rigging

cabin's bracket installation. This rigging must respect the linearity requirements on the internal shape of the cabin in terms of the luggage system. The alignment is ensured by the rigging of the Airbus 350's bracket type B, which supports the luggage compartment, as seen in figure 1.

The "as is" process was realized through the utilization of laser tracker technology, and the aircraft's center fuselage section is frozen for others operations in sequential mode.

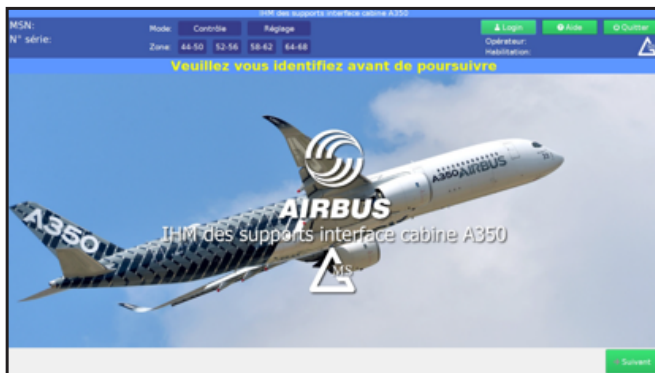


Figure 2. Airbus human-machine interface (HMI) portal



Figure 3. Airbus HMI portal—traceability identification

Several hundred interfaces were needed to rig into the center fuselage with various possible configurations. The total volume of this section is 21 m × 6 m.

The ramp-up of the cabin bracket installation at the Airbus pre-final assembly line site at St. Nazaire, France, was not possible with existing technology, and new processes and technologies were required to answer this challenge.

INNOVATIVE PHOTOGRAMMETRY APPLICATION

After walking through the process and closely consulting with all stakeholders, the team decided that a holistic approach to the separation of the measurement identification and the rigging was the best possible solution.

Measurement concept description

It was determined that the best way to perform this measurement was to replace the laser tracker technology with a photogrammetry option. However, the laser tracker was maintained as part of the project specifically to adjust the

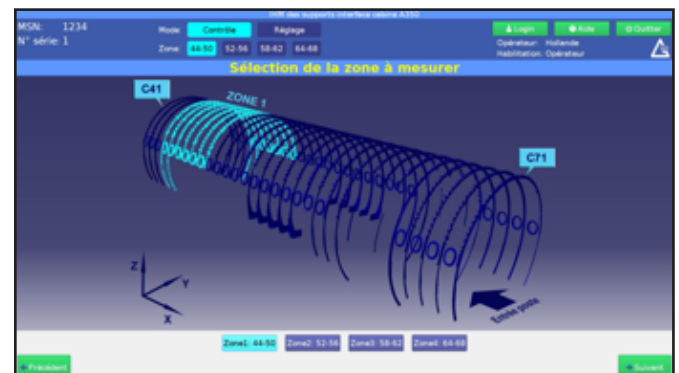


Figure 4. Airbus HMI portal—area selection

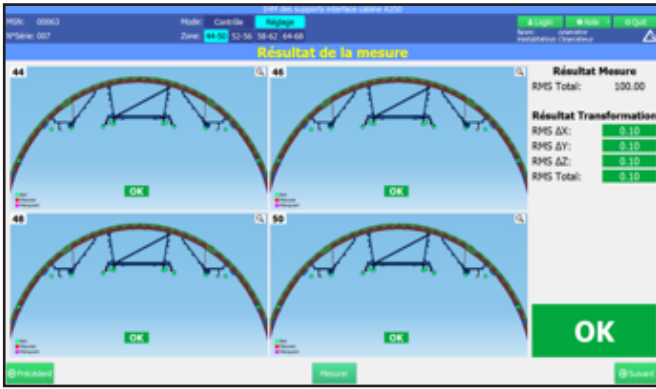


Figure 5. Airbus HMI portal—measurement and result view

twist leveling of the fuselage and to establish some reference points for the photogrammetry alignment and scaling.

The rigging installation was successfully executed after the initial measurement when a collection of smart tools equipped with opto-electronic sensors were connected to a personal digital assistant. This allowed the precise guidance and management of the rigging.

The advantages of this approach were as follows:

- **Instable mode measurement-capable.** This means that the section does not need to be frozen for other operators, thereby reducing lead time and increasing agility.
- **Measurement in one shot.** This permits configuration process capability without any negative effect on workload (i.e., the number of parts needed to be captured), thereby reducing lead time and increasing stability.
- **Parallelization of rigging operation assisted by smart tools.** This ensures new line balancing, thanks to concurrent work being allowed during the rigging process. This has the effect of reducing lead time and once again increasing agility.

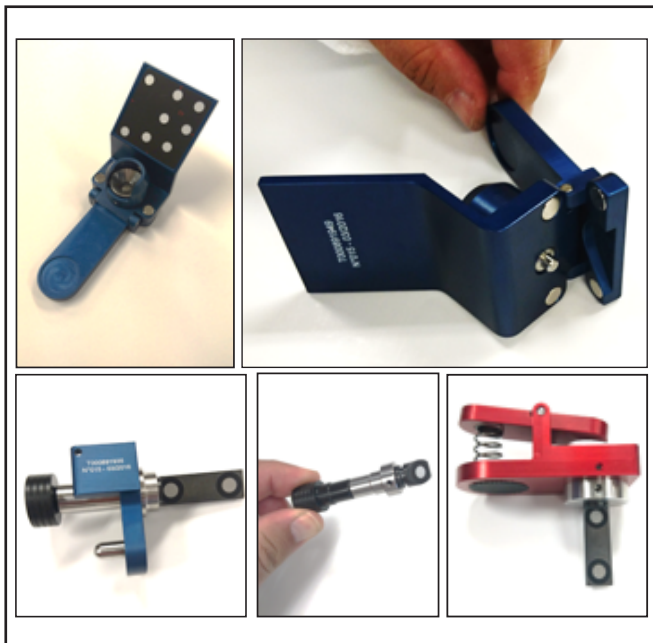


Figure 6. Examples of various target holders

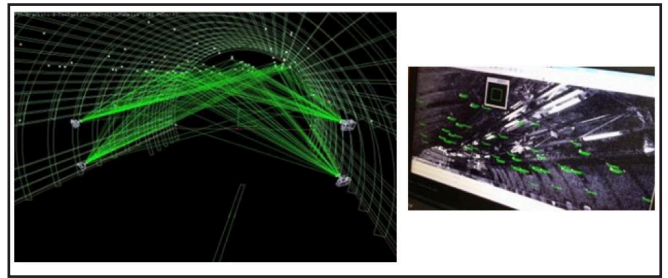


Figure 7. Plan of photogrammetric methods

Information technology process description and human-machine interface (HMI)

This new process is developed utilizing end-to-end digital process integration. In practical terms, that means the measurement data management is provided by the Airbus Metrology Software Suite and linked to product data management and the Airbus Operating System. Within this system, data obtained through photogrammetry, laser trackers, and opto-electronic technologies are fully integrated with a simple-to-use HMI for technicians.

User experience has validated that the operator-centered HMI reduces complexity for the operator, as seen in figures 2, 3, 4, and 5.

Target holder self-positioning concept

The advantages of the self-positioned magnetic target holders include quick installation and removal. Some examples of these target holders can be seen in figure 6.

Photogrammetry methods and hardware integration

Some features of this process include:

- Four zones over the entire length of the aircraft (approximately 21 m)
- 13 sections measured within those four zones
- Duration of measurement is 10 seconds by section
- Total measurement time of 20 minutes (includes post-treatment to capture the complete area of the aircraft section), as seen in figure 7
- Six reference targets in each of the four zones (24 in total), each measured by the laser tracker during the leveling process
- Alignment via common points on feature targets
- Coded targets installed to assist with automation of the measurement within the required volume



Figure 8. Red arrows indicate required points to be measured

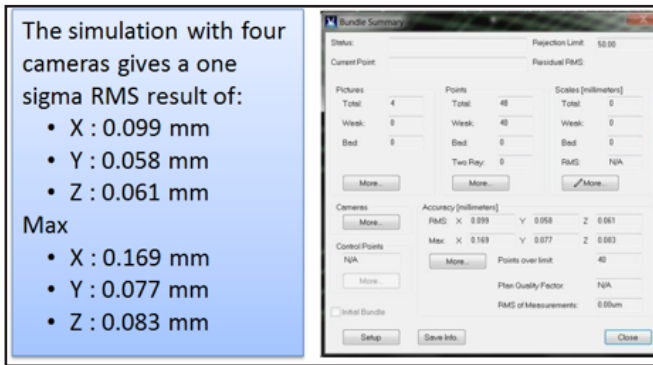


Figure 9. Simulation results



Figure 11. Portable station

- Coded targets with tooling to measure required points (as seen in the red arrows in figure 8)
- Coded targets were measured with six reference points per zone
- The close coordinates of the rigging for the B bracket points for automatic labeling in the theoretical file replacement were also measured (i.e., auto re-labeling)
- GSI's DynaMo D12 system was set up at the level of the 57 framework
- A script was enabled for the actual measurement of points; this script fired the cameras and completed the bundle
- The D12 system is placed on the aircraft floor and requires no stability; V-STARs directly calculates the differences between the theoretical and measured points, and these differences are expressed on axes X, Y, and Z of the sign corresponding to the six points of reference (as seen in figure 9)
- The delta of the X, Y, and Z axes were computed to assist the bracket-adjustment feature and verification (as seen in figure 10)
- The cameras were positioned at the level of the 57/58 framework at a height of 400 mm
- All targets were visible from these two positions, as seen in figure 11
- The acquisition of images lasts 6 seconds and the calculation requires 10 seconds

- 2) The quick installation, removal, and self-positioning of the magnetic target holders
- 3) Smart-tools rigging assisted by measurement

Production feedback indicated:

- An integrated measurement system is feasible if it can be made simple to use
- A reduced level of knowledge is possible for these technologies to be used by technicians
- The unstable mode allows working in parallel of other operations
- Measurement identification after bracket rigging is more stable (without human factors, as in the laser tracker measurement watch mode)

CONCLUSIONS

There were three differentiating innovations derived from this project, as follows:

- 1) Data fusion of photogrammetry with smart rigging tool, as seen in figure 12 (i.e., an opto-electronic sensor)

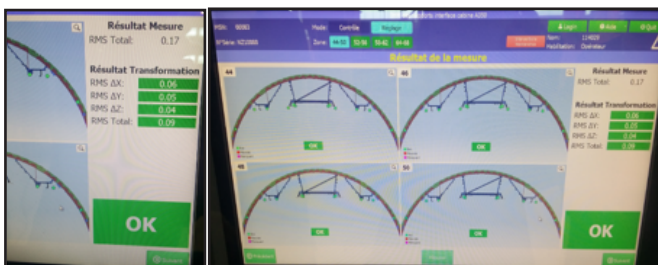


Figure 10. Performance results, post-deployment

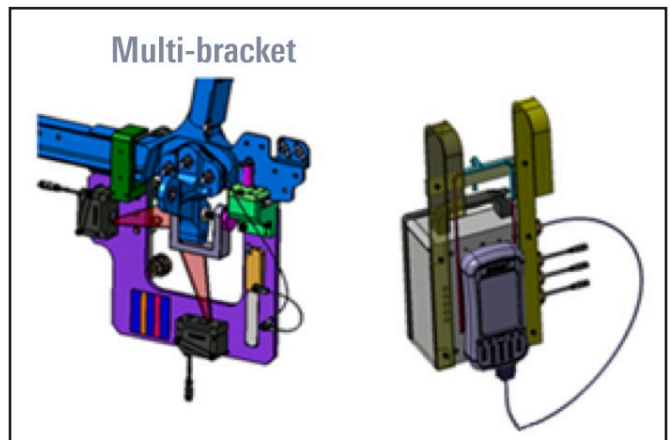


Figure 12. Example of smart tools used for rigging